

DRAFT:
(October 23, 2002)

December 17, 1999 and December 23, 1999
Episode Synoptic Discussion

December 10, 1999 – December 31, 1999

The period from December 10, 1999 through December 31st, 1999 was marked by 21 days of strong stability and poor atmospheric dispersion conditions. Strong high pressure over the Intermountain Region dominated the period, leading to light and disorganized wind flow and limited dispersion. The period began with the passage of a weak cold front and trough on the 9th. Between the 10th and the 17th, increasing stability and poor dispersion conditions resulted in a PM₁₀ exceedance at Corcoran on the 17th.

At Corcoran, a 24-hour PM₁₀ (Particulate Matter) concentration of 174 µg/m³ was measured. **Table 1** outlines federal reference method (FRM) Daily Average Particulate Matter measurements for sites across the San Joaquin Valley (SJV). In order to understand the variability of these measurements, an in depth examination of the synoptic pattern and surface winds and observations, and aircraft soundings leading to the episode were analyzed.

TABLE 1: Federal Reference Method (FRM) Daily Average Particulate Matter measurements for sites across the SJV for December 17, 1999.

FRM			FRM			FRM		
Site Name		24-Avg.	Site Name		24-Avg.	Site Name		24-Avg.
	10	2.5		10	2.5		10	2.5
Bakersfield-Gold		92	Modesto	99	93	Corcoran*	174	
Bakersfield-CA	111	90	Merced-M St.		75	Stockton**		78
Visalia		114	Clovis		18	Fresno-1st		107

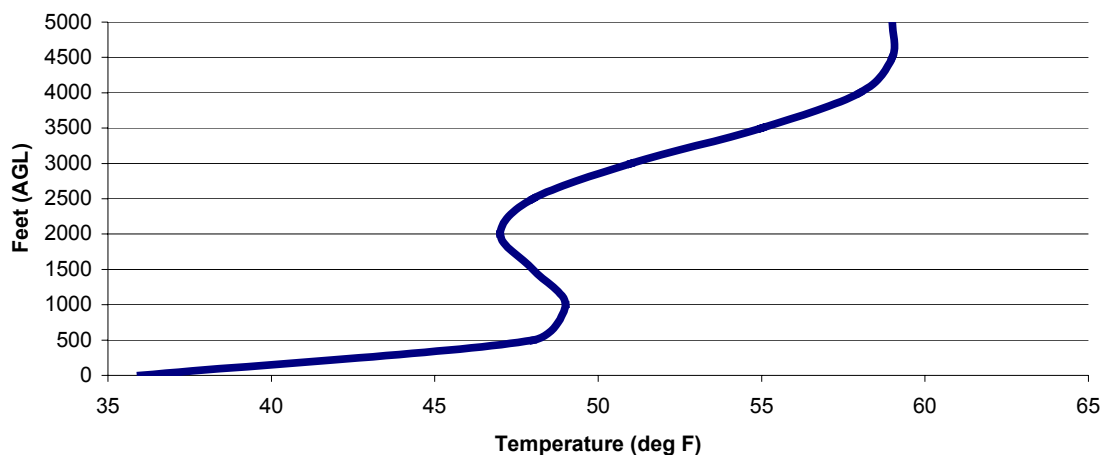
*-Patterson **- Hazleton
units in µg/m³

The meteorological synoptic analysis showed a period of moderately strong atmospheric stability from December 10th through the 17th. Ahead of a developing trough over the eastern Pacific, a strong mid and upper level ridge developed over the region on the 17th. This ridge strengthened the inversion over the San Joaquin Valley trapping particulates within the Valley boundary layer. The morning surface charts of the 17th depicted a strong surface high over the Great Basin and Intermountain Region. The 12Z (4 a.m.) surface pressure gradient was +1.8 millibars from San Francisco (SFO) to Las Vegas (LAS), with isobars (constant surface pressure) orientated west to east. The alignment of the isobars and the +1.8 millibars pressure gradient, represents

light and disorganized wind flow across the San Joaquin Valley. Visibilities throughout the day across the San Joaquin Valley were reporting haze.

The morning temperature aircraft sounding over Fresno on the 17th showed multiple inversions, with a strong inversion (stable layer) of 13 degrees Fahrenheit from the surface up to 1,000 feet, with a secondary strong inversion of 11 degrees Fahrenheit from 2,500 to 5,000 feet as is evident in **Figure 1**. The morning temperature sounding over Bakersfield also showed multiple inversions, with a strong inversion of 15 degrees Fahrenheit from the surface up to 3,000 feet, with a secondary strong inversion of 11 degrees Fahrenheit from 4,500 feet to 5,000 feet. The temperature sounding on the 17th, is conducive of elevated PM levels due to low mixing depths and multiple inversions, which keep pollutants trapped near the surface. During the early morning surface observations across the San Joaquin Valley were cold. The minimum temperatures recorded at Fresno and Bakersfield were 33 degrees Fahrenheit. The maximum high temperatures recorded at Fresno and Bakersfield were 59 degrees Fahrenheit. Fresno hourly temperature data shows very limited mixing conditions below 500 feet for over 18 hours of the day, increasing with minor afternoon heating to a maximum mixing depth of 2,000 feet on the 17th.

Figure 1: Atmospheric Temperature Profile at Fresno on December 17, 1999



Upper level charts indicated a strong high just west of Santa Barbara, with a ridge building northeastward into the Great Basin. A weak trough over the extreme Pacific Northwest extended southward to near Eureka. Weak pressure gradients across the San Joaquin Valley remained rather flat through the day, leading to light and disorganized wind flow across the San Joaquin Valley.

Table 2 shows the 24 hour daily average wind speeds at SJVAPCD monitoring, ASOS, and CIMIS sites for December 17, 1999.

SJVAPCD Monitoring Sites		ASOS		CIMIS			
	WS		WS		WS		WS
	mph		mph		mph		mph
Clovis	2.2	Fresno	1.7	Shafter/USDA	2.1	Famoso	2.4
Fresno SSP	1.4	Bakersfield	3.4	Firebaugh/Telles	2.2	Westlands	2.6
Corcoran	2.8	Hanford	1.0	Stratford	2.4	Panoche	2.6
Edison	3.3			Kettleman	2.6	Arvin-Edison	2.3
Parlier	3.2			Visalia/Americas	2.1	Lindcove	1.8
Arvin	2.2			Parlier	2.2	Kesterson	2.4
Visalia	1.6			Blackwells Corner	2.0	Lodi West	1.8
				Los Banos	2.8	Modesto	2.9
				Manteca	2.4	Fresno State	2.2

Due to the strong stability lasting for over 7 days, PM₁₀ steadily increase region-wide until the sampling day on December 17th. With the mid and upper level stability aloft, surface based inversion, and light and disorganized wind flow, this weather pattern was conducive of an elevated region-wide PM₁₀ measurements. At Visalia and Fresno 1st, fine particulates were above 100 µg/m³, further suggesting a widespread PM event across the San Joaquin Valley.

After a weak upper level trough passage on the 18th, strong high pressure rebuilt into the region from the eastern Pacific, with increasing stability and poor dispersion conditions through the next exceedance date on December 23rd at Fresno-Drummond Street and Hanford-Irwin Street. At Fresno-Drummond, a 24-hour PM₁₀ concentration of 168 µg/m³ and at Hanford a 24-hour PM₁₀ concentration of 156 µg/m³ was measured.

Table 3 Federal Reference Method (FRM) Daily Average Particulate Matter and **Table 4** California Regional Particulate Air Quality Study (CRPAQS) Measurements shows for sites across the San Joaquin Valley (SJV) for December 23. In order to understand the variability of these measurements, an in depth examination of the synoptic pattern and surface winds and observations, and aircraft soundings leading to the episode were analyzed.

TABLE 3: Federal Reference Method (FRM) Daily Average Particulate Matter Measurements for sites across the SJV for December 23, 1999.

	FRM			FRM			FRM	
Site Name	24-Avg.		Site Name	24-Avg.		Site Name	24-Avg.	
	10	2.5		10	2.5		10	2.5
Bakersfield-Gold		74	Modesto	119	95	Corcoran*	135	91
Bakersfield-CA	109	72	Merced-M St.		83	Stockton**		79
Visalia		85	Clovis		22	Fresno-1st		119

* -Patterson #-Wagner, **- Hazleton

TABLE 4: California Regional Particulate Air Quality Study (CRPAQS) Daily Average Particulate Matter Measurements for Fresno-Drummond and Hanford-Irwin for December 23, 1999.

	CRPAQS
Site Name	24-Avg.
	10
Fresno-Drummond	168
Hanford-Irwin	156

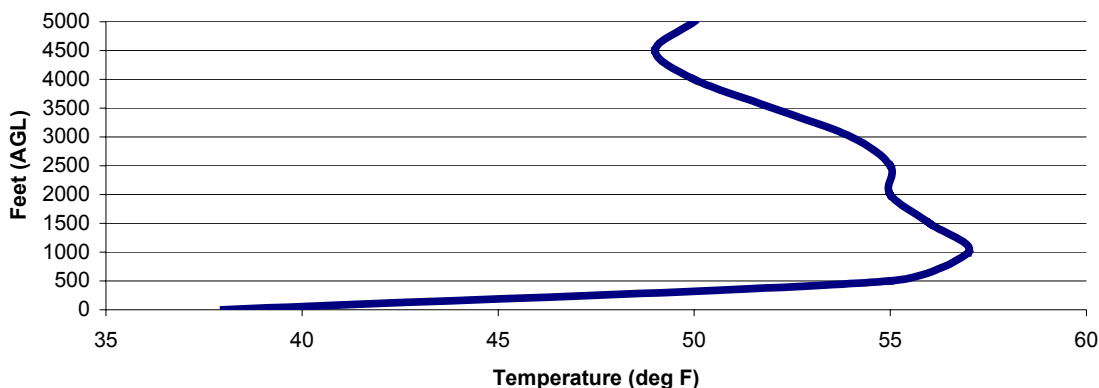
units in $\mu\text{g}/\text{m}^3$ for Table 3 and 4

The meteorological synoptic analysis showed after a period of strong atmospheric stability from December 18th through the 23rd, increasing stability and poor dispersion conditions lead to two exceedances measured using CRPAQS monitors at Fresno-Drummond and Hanford. The morning surface charts on the 23rd depicted a surface ridge extending southwestward across the central San Joaquin Valley from strong highs anchored over the Intermountain Region. The morning surface pressure gradient was -1.6 millibars from San Francisco to Las Vegas (SFO-LAS), with isobars (constant surface pressure) orientated southeast to northwest. With the alignment of the isobars and -1.6 millibars pressure gradient, this represents light southeasterly wind flow across the San Joaquin Valley. Visibilities across the San Joaquin Valley throughout the day reported hazy conditions.

The morning temperature aircraft sounding over Fresno depicted a strong inversion (stable layer) of 19 degrees Fahrenheit from the surface up to 1,000 feet as is evident in **Figure 2**. Bakersfield showed a strong inversion of 12 degrees Fahrenheit from the surface up to 1,000 feet turning isothermal up to 3,000 feet. The temperature soundings on the 23rd are indicative of elevated PM levels due to low mixing depths and strong inversions, which trap pollutants near the surface. During the early morning surface observations across the San Joaquin Valley were cold. The minimum temperatures recorded at Fresno and Bakersfield were 34 and 36 degrees respectively. The maximum high temperatures recorded at Fresno and Bakersfield were 62 and 64 degrees Fahrenheit respectively. Fresno hourly temperature data shows very limited

mixing conditions below 500 feet for over 16 hours of the day, increasing with minor afternoon heating to a maximum mixing depth of 2,000 feet on the 23rd

Figure 2: Atmospheric Temperature Profile at Fresno on December 23, 1999



Upper level charts indicated a strong high 600 NM west of Santa Barbara, with a ridge building northward along the West Coast into the eastern Gulf of Alaska. Pressure gradients remained weak throughout the day leading to poor dispersion conditions across the San Joaquin Valley.

Table 5 shows the 24 hour daily average wind speeds at SJVAPCD monitoring, ASOS, and CIMIS sites for December 23, 1999.

SJVAPCD Monitoring Site		ASOS		CIMIS			
	WS mph		WS mph		WS mph		WS mph
Clovis	2.5	Fresno	1.5	Shafter/USDA	2.5	Famoso	2.5
Fresno SSP	2.1	Bakersfield	3.1	Firebaugh/Telles	2.5	Westlands	3.0
Corcoran	3.3	Hanford	1.6	Stratford	3.3	Panoche	2.7
Edison	3.7			Kettleman	3.3	Arvin-Edison	2.6
Parlier	3.9			Visalia/Americas	2.5	Lindcove	1.8
Arvin	2.4			Parlier	2.7	Kesterson	2.1
Visalia	1.7			Blackwells Corner	2.1	Lodi West	1.7
				Los Banos	2.8	Modesto	2.4
				Manteca	2.4	Fresno State	2.3

The period of December 10, 1999 through December 31st, 1999, marked one of the longest periods of strong stability in recent history. This pattern was similar to the one experienced during the California Regional Particulate Air Quality Study. The main difference between the two episodes was the CRPAQS event began a week later and continued into the early part of January. During the exceedances of 1999, they were preceded by an exceptionally dry fall. After a weak frontal passage on the 10th, which brought a cold air mass to the Valley, this air remained trapped within the Valley

boundary layer resulting in strong surface based inversions. Coupled with the synoptic and surface pattern, which was indicative of light and disorganized wind flow, PM became a region-wide problem until a weak trough scoured out the area on New Year's Eve. As is evident in the PM data, local emissions contributed to the exceedance of the National Ambient Air Quality Standards at Corcoran on the 17th and Fresno-Drummond, and Hanford on the 23rd. If monitoring were done on a daily basis, more exceedances would have been recorded during this time frame at other San Joaquin Valley locations.